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N° 763.458

M. Hout

FIG: 1

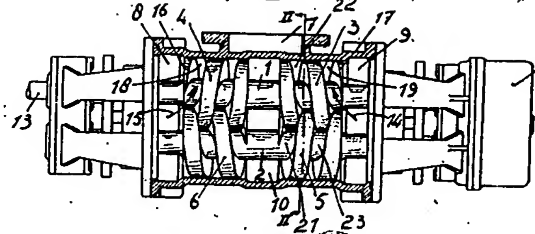


FIG: 2

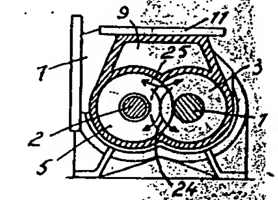


FIG: 3

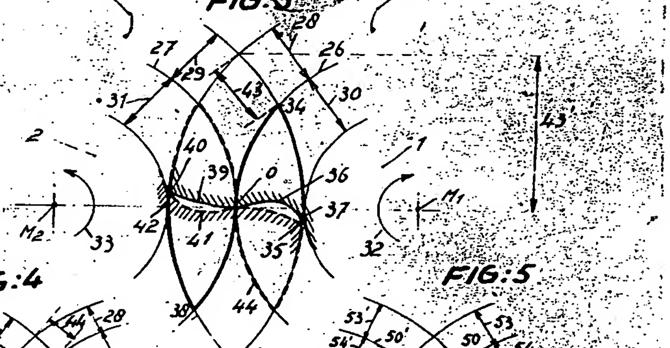


FIG: 4

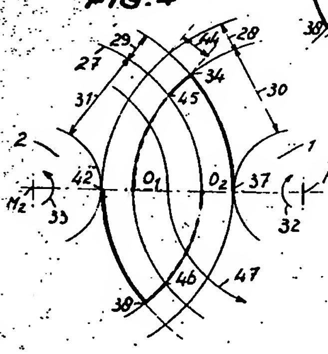
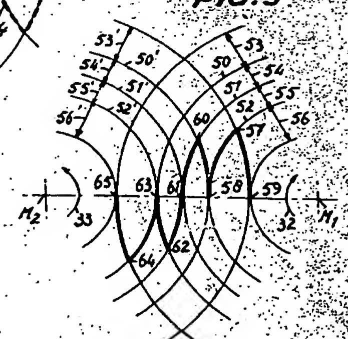


FIG: 5



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Pl. unique

FIG:6

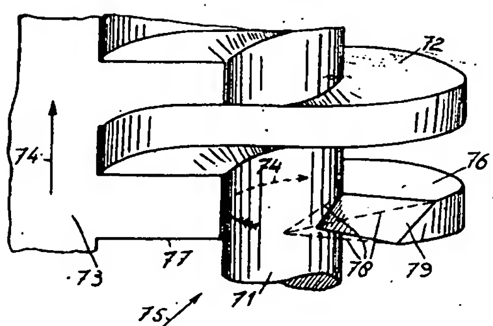


FIG:7

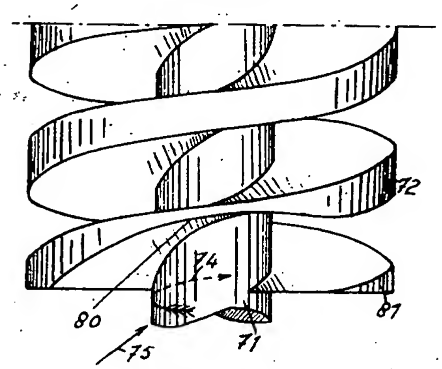
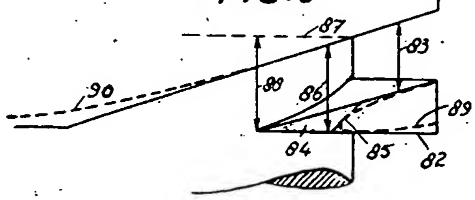


FIG:8



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BREVET D'INVENTION.

Gr. 5. — Cl. 1. **N° 763.458**

Pompe à vis sans fin.

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La présente invention se rapporte à une pompe à vis sans fin comportant une ou plusieurs desdites vis sans fin, enveloppées étroitement par une paroi et dans laquelle les filets ainsi formés sont pourvus, par endroits, d'organes d'étanchéité qui se déplacent avec eux de façon qu'il se forme, entre les filets, des chambres fermées qui se déplacent continuellement dans le sens axial des vis sans fin lorsque celles-ci tournent. On connaît déjà de nombreux modes d'exécution de pompes de ce type. Il existe notamment des pompes à vis sans fin dans lesquelles un organe en forme de peigne se trouve dans un plan axial de la vis sans fin, organe qui s'engage latéralement dans les filets de la vis sans fin et qui affecte par exemple la forme d'une roue dentée grâce à laquelle on constitue continuellement, dans lesdits filets, diverses chambres qui s'étendent chacune sur un pas de vis. Lorsque la vis sans fin tourne, l'organe précité en forme de peigne continue à occuper le même plan axial, mais il est poussé continuellement en avant dans le sens axial, par le mouvement hélicoïdal, grâce à quoi les chambres hélicoïdales sont, elles aussi, déplacées. On réalise ainsi un transport continu de liquide dans le sens axial, le long de la vis sans fin. Comme organe d'étanchéité, on peut utiliser une autre vis sans fin. On réalise ainsi un type de pompe à vis sans fin dans laquelle deux ou plusieurs vis sans fin parallèles s'engagent l'une dans l'autre et sont renfermées ensemble dans une paroi qui les entoure étroitement. Dans le cas de deux vis sans fin, la paroi affecte la forme d'un 8.

La difficulté dans cette construction est de réaliser une étanchéité satisfaisante des filets des vis sans fin l'un par rapport à l'autre, c'est-à-dire une fermeture hermétique de deux flancs de filets coopérants, l'un sur l'autre. L'étanchéité doit être obtenue à deux points de vue. D'abord l'espace entre les filets situé d'un des côtés d'un plan imaginaire passant par les axes des vis sans fin doit être fermé par rapport à l'espace correspondant situé de l'autre côté de ce plan. Lorsque, dans cette organisation, il y a une fuite entre les deux vis sans fin (et ceci se répète dans ce cas pour tous les flancs de filets qui coopèrent ensemble), toutes les chambres de transport sont réunies les unes aux autres, et il s'établit une communication plus ou moins libre entre l'aspiration et le refoulement de la pompe. Ensuite, il faut tenir compte du fait que deux flancs coopérants doivent s'écarter l'un de l'autre avant qu'ils ne reviennent en contact avec la paroi du carter (par exemple en forme de 8) qui les entoure.

blir le flanc de la vis sans fin en deux éléments de surface (tête et pied) qui se touchent (ou se délimitent) suivant une ligne hélicoïdale normale, grâce à quoi le profil de la partie supérieure du flanc est déterminé par les trajets que décrivent les points des lignes-limites correspondantes qui se trouvent sur le flanc coopérant de l'autre vis sans fin, tandis que le profil de la partie constituant le pied du flanc est déterminé par les trajets que décrivent les points du bord extérieur (sommet) du flanc de l'autre vis sans fin. Le bord supérieur du premier flanc peut ici toucher le pied du deuxième flanc et la ligne-limite de ce dernier peut toucher la tête du premier flanc, de l'un des côtés d'un plan imaginaire passant par les axes des deux vis sans fin, tandis que de l'autre côté de ce plan le bord supérieur du deuxième flanc vient en contact avec le pied du premier et que la ligne-limites de celui-ci vient en contact avec la tête du deuxième flanc. Les lignes de contact (d'engrènement) par lesquelles deux flancs coopérants se touchent et qui affectent la forme de deux courbes ogivales (ogives) dont une se trouve de chaque côté du plan imaginaire passant par les axes des vis sans fin, peuvent former une courbe continue ou bien les parties des ogives, parties qui coïncident avec les lignes-limites des flancs, peuvent être déplacées vers les parties supérieures de la vis sans fin, par conséquent dans le sens radial, de telle manière que les points, au pied des ogives, ne coïncident plus.

On a constaté que les pompes à vis sans fin, surtout les pompes pour les liquides très visqueux, présentent le grand inconvénient que les chambres ne sont que rarement tout à fait remplies. La vitesse d'entrée et les sections de passage d'entrée des chambres formées par les vis sans fin sont trop petites pour pouvoir, au cours du temps relativement court pendant lequel une telle chambre reste ouverte et reste par conséquent en communication avec la chambre d'aspiration de la pompe, réaliser le remplissage complet de ladite chambre. Ceci conduit à une diminution du rendement et de l'effet utile de la pompe. Il en résulte constamment un certain espace vide dans la chambre et ceci présente à son tour l'inconvénient, pour les liquides volatils, d'un dégagement supplémentaire de vapeurs.

La présente invention écarte cet inconvénient par le fait que l'extrémité libre d'entrée du filet par où passe le liquide est élargie. De cette façon on réalise une arrivée plus grande de liquide dans les chambres constituées par les filets et, partant, un certain effet de pression tendant à faire entrer le liquide.

Sur le dessin annexé on a représenté, à titre d'exemple, un mode d'exécution de l'invention ainsi que plusieurs schémas servant à montrer clairement le contact entre deux flancs, la forme de ces flancs et l'exécution de l'extrémité d'entrée. Sur ce dessin :

La figure 1 est une coupe horizontale d'une pompe à vis sans fin exécutée conformément à l'invention, ladite pompe comportant deux vis sans fin horizontales disposées l'une à côté de l'autre et présentant chacune deux filets séparés ;

La figure 2 est une coupe suivant II-II de la figure 1 ;

La figure 3 est un schéma de deux flancs de vis sans fin coopérant l'un avec l'autre, la figure indiquant les lignes de contact et les profils des flancs ;

La figure 4 est analogue à la figure 3, mais montre une forme d'exécution modifiée, toutefois sans le profil de flanc ;

La figure 5 est un schéma analogue à celui de la figure 4, mais elle se rapporte à des flancs constitués par quatre éléments de surface ;

La figure 6 est une vue latérale de la vis sans fin d'une pompe à une seule vis sans fin, pourvue d'un organe en forme de peigne et disposé dans un plan axial ;

La figure 7 représente une vis sans fin perfectionnée également conformément à l'invention et susceptible d'application dans diverses espèces de pompes à vis sans fin ;

La figure 8 enfin, montre encore schématiquement les deux formes d'exécution possibles conformément aux figures 6 et 7.

Sur la figure 1 on a désigné par 1 et par 2 les arbres des vis sans fin pourvus, l'un de filets 3 et 4 et l'autre, de filets 5 et 6. La tubulure d'aspiration 7 communique avec les espaces 8 et 9 tandis que la chambre de

29 de la vis sans fin M2. On réalise ainsi l'étanchéité tout le long de la ligne 0-34. Le bord supérieur ainsi obtenu du filet de la vis sans fin M2 et déterminé par le point 35 est utilisé ensuite pour déterminer le profil du pied 30 du flanc de la vis sans fin M1. On obtient ainsi la ligne 36. L'étanchéité règne tout le long de la ligne 34-37.

D'une façon absolument semblable, mais en opérant en sens inverse, on détermine le profil 26 de la tête du flanc de la vis sans fin M1 par le trajet du point 0 (pour autant qu'il se trouve sur la vis sans fin M2) et par conséquent par la ligne 27. On obtient ainsi une ligne de contact, le long de laquelle règne l'étanchéité ; cette ligne, désignée par 0-38, donne le profil correspondant à la vis sans fin M1, déterminé par la ligne 39 qui se termine au bord supérieur 40. Ce bord 40 détermine ensuite le pied 31 du flanc de la vis sans fin M2, grâce à quoi on obtient la ligne de profil 41. L'étanchéité entre le profil 41, c'est-à-dire entre le pied 31 du filet de la vis sans fin M2 et le bord supérieur 40 du filet de la vis sans fin M1, s'établit le long de la ligne 42-38.

On obtient ainsi une ligne continue 37-34-0-38-42 le long de laquelle règne l'étanchéité. On évite ainsi complètement les fuites entre les vis sans fin, c'est-à-dire de haut en bas ou *vice versa* en ce qui concerne la figure 3. La grandeur de l'intervalle qui rend les fuites possibles de gauche à droite ou de droite à gauche (voir les flèches 25 de la fig. 2) est fortement diminuée parce que la largeur dudit intervalle est considérablement diminuée. Au point 34 n'existe plus qu'un intervalle d'une largeur indiquée par la ligne de cote 43 tandis que la hauteur primitive de l'intervalle devrait être celle indiquée par la ligne de cote 43^1.

On peut encore faire remarquer que, pour l'autre flanc de la partie envisagée du filet de la vis sans fin on doit tracer une ligne correspondant à la ligne de contact qui vient d'être citée. Cette ligne est toutefois renversée et on l'a indiquée sur le dessin par la ligne en pointillé 44.

Sur la figure 3, on a fait coïncider les points 0 sur les deux flancs, ce qui signifie que l'on divise les flancs des vis sans fin en deux éléments de surface par une ligne hélicoïdale située exactement à mi-hauteur du flanc ou bien que les hauteurs de la tête et du pied des flancs sont égales. Ceci, évidemment, n'est pas indispensable. On peut, par exemple donner une plus grande hauteur au pied aux dépens de la hauteur de la tête comme le montre la figure 4. Pour autant que cela était nécessaire, on a utilisé sur la figure 4 les mêmes nombres de référence que sur la figure 3. Le point 0_1 appartient à la vis sans fin M1 et le point 0_2 à la vis sans fin M2. La largeur de l'intervalle désigné sur la figure 3 par 42 est, ici aussi, considérablement diminuée et on l'a désignée par la ligne de cote 44. Le point 0_1 détermine le profil 29 de la tête du filet de la vis sans fin M2. Il en résulte la ligne de contact 45-34. Le bord supérieur de la vis sans fin M2 détermine le profil du pied du filet de la vis sans fin M1, grâce à quoi on obtient la ligne de contact 34-37. Le point 0_2 détermine le profil de la tête du filet de la vis sans fin M1. Il en résulte la ligne de contact 46-38. Le bord supérieur de la vis sans fin M1 détermine ensuite le profil du pied du filet de la vis sans fin M2, ce qui conduit à la ligne de contact 38-42.

Ainsi qu'il a été dit plus haut, la hauteur 34 de l'intervalle diminue considérablement dans la construction représentée par la figure 4, mais il se produit de nouvelles fuites entre les vis sans fin, à savoir dans le sens de la flèche 47. Toutefois ces fuites ne doivent pas être importantes. D'ailleurs on a ainsi la possibilité de répartir les fuites inévitables sur l'intervalle 44 et sur l'intervalle qui se trouve sur la ligne qui réunit les axes des vis sans fin M1 et M2. On peut réduire ainsi les fuites totales au minimum, ce qui est important principalement dans le cas de liquides très visqueux, ces liquides passant avec une difficulté particulièrement grande par un intervalle qui devient de plus en plus petit.

On peut aussi constituer le profil du filet par plus de deux éléments de surface. C'est ainsi que sur la figure 5 on a représenté trois lignes hélicoïdales normales, désignées par 50, 51 et 52 respectivement, sur le flanc de la vis sans fin M1, grâce à quoi le flanc est divisé en quatre éléments de surface,

2° Le flanc des filets est constitué par deux éléments de surface, la tête et le pied, qui se touchent suivant une ligne hélicoïdale normale (limite), le profil de l'élément qui forme la tête étant déterminé par les trajets décrits par les points de la limite correspondante qui sont situés sur le flanc coopérant de l'autre vis sans fin tandis que le profil de l'élément qui forme le pied est déterminé par les trajets décrits par les points du bord extérieur (sommet) de l'autre flanc de filet;

3° Dans deux flancs coopérants qui s'étendent l'un jusque dans le voisinage immédiat de l'autre, si l'on considère l'un des côtés d'un plan imaginaire passant par les deux axes des vis sans fin, le bord supérieur du premier flanc vient sensiblement en contact avec la partie qui forme le pied du second et la limite du second flanc vient sensiblement en contact avec la partie qui forme la tête du premier flanc tandis que, si l'on considère l'autre côté dudit plan, le bord supérieur du deuxième flanc vient sensiblement en contact avec la partie qui forme le pied du premier flanc et que la limite du premier flanc vient sensiblement en contact avec la partie qui forme la tête du second flanc;

4° Les lignes de contact ou d'engrènement suivant lesquelles viennent sensiblement en contact deux flancs qui coopèrent ensemble, lignes qui affectent la forme de deux ogives, sont situées l'une d'un des côtés et l'autre de l'autre côté d'un plan imaginaire passant par les axes des vis sans fin et forment une courbe continue;

5° Les parties des ogives qui coïncident avec les limites des flancs sont déplacées vers les sommets des filets, par conséquent radialement, de telle façon que les points correspondant aux pieds des ogives ne coïncident plus;

6° Dans une pompe du type précité comportant une ou plusieurs vis sans fin enveloppées étroitement par une paroi et dont les espaces ainsi formés entre les filets sont pourvus, par endroits, d'organes d'étanchéité qui se déplacent avec lesdits filets de manière à former dans ces espaces des chambres fermées qui se déplacent continuellement dans le sens axial le long de l'axe de la vis sans fin lorsque cette dernière tourne, on élargit l'orifice d'entrée du liquide dans le filet;

7° La languette en forme de pointe terminant le filet de la vis sans fin, du côté de l'orifice d'entrée du liquide, présente une obliquité de même sens que celle du filet mais plus accentuée, la pointe extrême de ladite languette étant abattue;

8° La partie du flanc du filet qui est située vis-à-vis de la languette pointue susvisée terminant ledit filet du côté de l'orifice d'entrée du liquide dans le filet est creusée ou abattue en partie;

9° On arrondit tous les angles vifs du côté de l'orifice d'entrée;

10° La pompe a deux vis sans fin parallèles s'engageant l'une dans l'autre et enveloppées par une paroi en forme de 8.

Cornelis HOUTTUIN.

Par procuration :

Dom. Casalonga.

Translation of French patent no. 763458, gr. 5- cl. 1, to Cornelis Houttuin residing in the Netherlands, applied for Oct. 11, 1933, granted Feb. 12, 1934, published May 1, 1934. (2 applications filed in the Netherlands on Sept. 25, 1933 - statement of applicant).

Worm pump.

The present invention relates to a worm pump having one or more of the said worms closely encased by a wall and in which the threads thus formed are provided at intervals with packing means which are displaced with them in such manner that there will be formed between the threads closed compartments which are shifted continually in the axial direction of the worms when the latter are rotated. Many embodiments of pumps of this type are known in which an organ in the form of a comb is located in an axial plane of the worm, an organ which engages laterally in the thread of the worm and which affects , for example, the form of a toothed wheel owing to which there are continually constituted in the said threads various compartments which extend each for one thread of the worm. When the worm turns the organ mentioned above of comb - like shape continues to occupy the same axial plane but is pushed continually forward in the axial direction by the helical movement, thanks

to which the helical compartments are displaced. Thus we realize a continuous transportation of liquid in the axial direction lengthwise of the worm. As packing organ we can use another worm. Thus we shall realize a type of worm pump in which two or more parallel worms are engaged in one another and are inclosed in a wall structure which closely surrounds them. In the case of two worms the wall has the form of an 8.

The difficulty in this construction is in realizing a satisfactory tightness of the threads of the worms with respect to one another, that is to say a hermetic closing of two flanks of cooperating threads on one another. The tightness must be obtained with two points in mind. In the first place the space between the threads situated on one of the sides of an imaginary plane passing through the axes of the worms must be closed with respect to the corresponding space situatedon the other side of this plane. When in this constructive arrangement there is a leak between the two worms(and this is repeated in such a case for all the flanks of threads which cooperate) all the conveying compartments will be combined and a more or less free communication will be established between the exhaust and delivery sides of the pump. Lastly, account must be taken of the fact that two cooperating sides must

move apart before they come into contact again with the wall of the case (in the form of an 8 for example) which surrounds them. As a result we have intervals or slots directed perpendicularly to the imaginary plane passing through the axes of the two worms or more exactly directed along the inclination of the thread of the worm. This permits escapes of the liquid from a chamber or compartment belonging to one of the worms to the other worm. As this phenomenon is repeated continuous leaks will occur from the time of delivery to the time of exhaust of the pump , leaks which may be of importance. We can proceed with a certain fashioning of the flanks, for example with a notch or recess in one of the flanks which may or may not be accompanied by the fashioning of the other flank with a rounded profile. We may also use a worm with a cycloid profile.This , how - ever, does not bring any improvement.

We can also try to avoid the above mentioned intervals practically perpendicular to the imaginary plane passing through the axes of the worms and ~~allowing~~ consequently leaving the upper part of the worm without coming into contact with the entire profile of the adjacent flank. There results from this a relatively inconsiderable interval in the imaginary plane passing through the axes of the two worms whence occur fresh leaks or escapes of liquid from one of the sides of the said plane to the other side.

To limit the leaks as far as possible it has already been proposed to fashion the worms so that they will have a graduated form and to utilize consequently a method of construction in accordance with which the worm will have the form of a spiral staircase. Thus we realize a closure which should be considered as a closure by contact surfaces instead of the linear closure of the forms of construction described above and which , consequently, manifests in all cases a"labyrinth"effect. The disadvantage of this method of construction is , however, that the surfaces of the graduations act as buckets or blades which agitate the liquid strongly in the compartments. Eddies result. In the case of volatile liquids such as gasoline this fact presents the great disadvantage that it causes greater losses by evaporation. In the case of very viscous fluids such as mixtures containing asphalt there result losses in power in consequence of the resistance offered to the forward movement of the above mentioned buckets or steps. These circumstances constitute a considerable disadvantage for we intentionally use these pumps precisely for the liquids above mentioned because , in principle, the said pumps offer the possibility of an easy transportation with few eddies, etc. that is to say with a uniform speed throughout the mass of the liquid set in motion which we must endeavor to preserve as far as possible.

The present invention creates the possibility of realizing a better tightness than that which could be produced hitherto without any result causing the formation of eddies in the liquid which it is desired to pump and that because in conformity with the said invention we constitute a worm flank by different surface elements which are limited with respect to one another along normal helical lines. This permits realizing at the same time the complete tightness of one of the sides of the imaginary plane passing through the axes of the worms with respect to its other side and to diminish considerably in this way the depth of the intervals which are directed approximately in a perpendicular direction to this surface (see above) which diminishes their surface and consequently the leaks. If, after that , we wish to reduce still further the depth of the said intervals we can do so; there result , however, in addition, certain leaks from one side of the imaginary plane passing through the axes of the worms toward the other side although this path offers a great resistance to the passage of the stream of liquid. In this last manner we can furthermore distribute the leaks which may present certain advantages because, for example, for very viscous liquids the resistance to the total sum of the leaks may become much greater and consequently diminish the leaks.

In accordance with the invention we can establish the flank of the worm in the form of two surface elements (head and foot) which touch(or are delimited) along a normal helical line by virtue of which the profile of the upper part of the flank is determined by the lines which the points of the corresponding limiting lines describe which are on the flank cooperating with the other worm while the profile of the part constituting the foot of the flank is determinedby the lines described by the points of the outer edge (top) of the flank of the other worm. The upper edge of the first flank can here touch the foot of the second flank and the limiting line of the latter can touch the head of the first flank of one of the sides of the imaginary plane passing through the axes of the two worms while on the other side of this plane the upper edge of the second flank comes into contact with the foot of the former and the limiting line of the latter comes into contact with the head of the second flank. The lines of contact (of engagement) ~~by which two flanks~~ by which two cooperating flanks touch one another and which have the form of two ogival curves (ogives) one of which is on each side of the imaginary plane passing through the axes of the worms

may form a continuous curve or parts of ogives, parts which coincide with the limiting lines of the flanks, which may be displaced toward the upper parts of the worm,, consequently in a radial direction in such manner that the points at the foot of the ogives will not coincide.

It has been noted that worm pumps , especially pumps for very viscous liquids have the great disadvantage that the compartments are but rarely fully filled. The speed of admission and the cross sections of passage admitting into the chambers or compartments formed by the worms are too small to be able in the course of the relatively short space of time during which such a chamber or compartment remains open and remains consequently in communication with the suction chamber of the pump to effect the complete filling of this chamber. This leads to a diminution in output and in efficiency of the pump. There results constantly a certain empty space within the chamber and this in its turn entails the disadvantage,for volatile liquids, of a supplementary liberation of vapors.

The present invention avoids this disadvantage by the fact that the free endbeginning the thread through which passes the liquid is enlarged. In this way we effect a greater admission of liquid into the chambers constituted by the threads and , thereby a certain pressure effect tending to make the liquid enter.

In the attached drawing we have shown by way of example one mode of execution of the invention as well as several diagrams serving to show clearly the contact between two flanks,the form of these flanks and the construction of the admission end. In this drawing:

Fig.1 is a horizontal section of a worm pump constructed according to the invention, the said pump having two horizontal worms disposed one beside the other and each having two separate threads.

Fig.2 is a section along II - II of fig.1.

Fig.3 is a diagram of two worm flanks cooperating with one another, the figure indicating the lines of contact and the profiles of the flanks.

Fig.4 is analogous to fig.3 but shows a modified form of construction, without , however, the profile of the flank.

Fig.5 is an analogous scheme to that of fig.4 but it relates to flanks constituted by four surface elements.

Fig.6 is a lateral view of the worm of a worm pump provided with a comb shaped device and disposed in an axial plane.

Fig.7 shows an improved worm likewise in conformity with the invention and capable of application to various kinds of worm pumps.

Fig.8 , lastly, shows , again in diagrammatic form, the two possible constructions in conformity with figs.6 and 7.

In fig.1 we have designated by 1 and by 2 the shafts of the worms provided one with threads 3 and 4 and the other with threads 5 and 6. The suction or exhaust pipe 7 communicates with the spaces 8 and 9 while the delivery chamber 10 is connected to the delivery pipe 11. The two worms are engaged in one another , the highest points of each thread extending as far as the shaft of the other worm. The worms have been given such a form that they do not touch anywhere, strictly speaking, but leave free everywhere very slight intervals thanks to which there is no friction between these parts and consequently no wear of the said parts. However the two worms must for this reason both driven and that by means of toothed wheels constructed in a very precise manner and protected in a case 12. The whole is driven from the pivot 13.

The pump functions in the following manner: the liqui which is in the spaces 8 and 9 can flow every time into the first chamber of the thread of the worm as indicated by the arrows 14 and 15. Whenthe worms continue to turn (they have oppositely directed threads and furthermore turn in opposite directions) the tongues 16 and 17 again come into contact with the terminal flanks of the worms 6 and 5 thanks to which the chambers 18 and 19 which have just been filled are isolated from the exhaust of the pum

When the worms continue to turn the chamber thus formed is shifted in the axial direction lengthwise of the shaft of the said worm and finally discharges its contents into the delivery chamber 10.

Therefore we must try to realize a tightness as great as possible between the worms. To that end as follows:

1. The leaks or escapes of liquid must be limited in a downward direction with respect to the surface of fig.1 of the drawing, that is , between the worms. This would put into communication , for example, the chambers 21 and 22 and chambers 23 and 19. This leak is indicated by the arrows 24 in fig.2.

2. We must seek to restrict as far as possible such leake , for example from the chamber 21 to the chamber 22 and from chamber 23 to chamber 19. These leaks are indicated in fig. 2 by arrows 25. The intervals betwe the flanks of the teeth, intervals by which these leaks are caused are almost perpendicular to the imaginary plane which passes through the axes of the worms.

In conformity with fig.3 we act in the following manner:

Here too we have designated by 1 the shaft of one of the worms and that of the other by 2. The threads are designated by 3 and by 5. The top of the thread 5 extends as far as the shaft 1 (this , in the direction indicated above , that is to say with a slight play).

The axes of the shafts are designated by M1 and M2 which will likewise designate in what follows the worms properly speaking. We choose on the flank of the worm M1 a normal helical line 26 which intersects the line M1 - M2 at the point O. We can conceive of an analogous helical line 27 on the flank of the worm M2. In fig.3 the circular projections of these helical lines also come together at this point. The flanks of the worms are divided into two parts, namely the foot and the head, by the helical lines 26 and 27. The height of the head of the thread of the helical worm M1 is indicated by the line 28 and that corresponding to the helical worm M2 by the arrow 29. The height of the foot of the thread of the worm M1 is indicated by the line 30 and that of the foot of the thread of the worm M2 by the line 31.

The point O in so far as it is on the flank of the worm M1 slides upward starting from the point indicated by O on the worm M2 of fig.3 over the head 29 of the said worm M2 when the direction of rotation is that indicated by the arrows 32 and 33. The profile of the head 29 is determined then by the above mentioned line O- 34, that is to say , by the path of the point O in so far as it is on the worm M1. The construction of the profile may be brought about, of course, by known geometric and mathematical processes (analogous more or less to those

which are used for toothed wheels) and we then will have a profile such as the one indicated by the dotted line O - 35. This profile is , then, that of the head 29 of the worm M2. Thus we secure tightness along the line O -34. The upper edge , thus obtained, of the thread of the worm M2 and determined by the point 35 is then utilized to determine the profile of the foot 30 of the flank of the worm M1. Thus we obtain the line 36. The tightness will prevail all along the line 34 - 37.

In an absolutely similar manner but working in the opposite direction we determine the profile 26 of the head of the flange of the worm M1 by the path of the point O (in so far as it is on the worm M2) and consequently by the line 27. Thus we obtain a line of contact along which tightness prevails; this line, designated by O- 38 gives the profile corresponding to the worm M1 determined by the line 39 which is terminated at the upper edge 40. This edge 40 then determines the foot 31 of the flank of the worm M2, thanks to which we can obtain the profile line 41. The tightness between the profile 41 , that is between the edge 31 of the thread of worm M2, and the upper edge 40 of the worm 31 is established along the line 42 - 38.

Thus we obtain a continuous line 37- 34-0- 38-42 along which tightness prevails. Thus we avoid completely the leaks or escapes of liquid between the worms, that is to say, from top to bottom or vice versa , if we consider fig,3. The magnitude of the interval which makes the leaks possible from left to right or from right to left (see the arrows 25 of fig.2) is greatly diminished because the width of the said interval is considerably diminished. At the point 34 there exists only an interval of a width indicated by the line 43 while the original height of the space must be that indicated by the line 43^1.

It might also be remarked that for the other flank of the part of the worm thread considered we must draw a line corresponding to the line of contact which has just been cited. This line is , however, reversed and we have indicated this in the drawing by the dotted line 44.

In fig.3 we have made the points O coincide on the two flanks which signifies that the flanks of the two worms are divided into two surface elements by a helical line situated exactly at helf the height of the flank or else the heights of the head and of the foot of the flanks are equal. This evidently is not indispensable. We may , for example , give a greater height to the foot at the expense of the height of the head as shown in fig.4. In so far as that was necessary we have used in

fig.4 the sa,e reference numbers as in fig.3. The point O belongs to the worm M1 and the point O2 to the worm M2. The width of the interval designated in fig.3 by 42 is here too considerably diminished and we have designated it by the line 44. The point O_1 determines the profile 29 of the head of the thread of the worm M_2. From that results the line of contact 45 -34. The upper edge of the worm M2 determines the profile of the foot of the thread of the worm M1 thanks to which fact we obtain the line of contact 34- 37. The point O_2 determines the profile of the head of the thread of the worm M1. From this results the contact line 46- 38. The upper edge of the worm M1 determines , then, the profile of the foot of the thread of the worm M2 which leads to the contact line 38-42.

As has been stated above the height 34 of the interval diminishes considerably in the construction shown in fig.4 but fresh leaks are produced between the worms, namely in the direction of the arrow 47. However, these leaks need not be important. Furthermore there is thus the possibility of distributing the inevitable leaks over the interval 44 and over the interval which is on the line which unites the axes of the worms M1 and M2. Thus we can reducethe total leaks to a minimum which is important chiefly in the case of very viscous liquids, these liquids passing with a particularly great difficulty through any interval which becomes smaller and smaller.

We can thus constitute the profile of the thread by more than two surface elements. Thus it is that in fig.5 we have shown three normal helical lines designated by 50, 51 and 52 respectively on the flank of the worm M1 thanks to which fact the flank is divided into four surface elements , namely a head 53, two median elements 54 and 55 and a foot 56. This is like - wise applicable to the worm M2, the reference numerals being given ths sign('). We use here the helical line 52 for the purpose of determining the profile of the head of the thread of the worm M2 by means of the contact line 57- 58. The upper edge of the thread of the worm M2 then determines the profile of the foot of the thread of the wormM1 by means of the contact line 57- 59 after which the line 50' determines , according to the line 60-58 the profile of the element 55. The upper edge of this element determines , following the line 60 - 61, the profile of the surface element 54' of the worm M2. Pursuing these determinat- ions we obtain a ~~greatly~~ sharply broken line 59-57-58-60-61-62-62-63-64-65 which realizes a complete tightness between the worms as well as a diminution in the height of the perpendicular interval of the imaginary plane passing through the axes of the worms. This dimi- nution is , however, less than that which we realize in conform- ity with fig.3. Furthermore, the broken line mentioned above must not be in this case too a continuous one and here we can apply again the principle of the construction shown in fig.4.

En fig.6 we have designated by 71 the shaft and by 72 the thread of the worm. We have designated by 73 a packing device (in the form of a comb) which is moved at the same time and by

means of which closed chambers are formed between the threads. When the worm turns in the direction of the arrow 74 the organ 73 which may be made , for example, in the form of a toothed wheel the axis of which crosses perpendicularly that of the worm is moved in the direction of the arrow 74. In the position shown the lower chamber of the thread is again open and consequentl: liquid can again flow into the same in the direction of the arrow 75. However, when the flank element 76 of the worm attains the side 77 of the organ 73 in the form of a comb the chamber will be closed. The pointed tongue which terminates the thread 72 on the side where the liquid is admitted is represented, for normal construction, by the dotted lines 78. However the extreme end of the said tongue is cut with an obliquity in the same direction as that of the threa(but more pronounced and which gave rise to the formation of the cutting plane 79. It is clearly apparent that the possibilities for the admission of liquid are thus greatly increased to which must be added the wedge effect of the plane 79 thanks to which the liquid is driven toward the inside, that is to say if we regard fig.6, upward.

In fig.7 we have made use of the same reference numbers in so far as was necessary. In order to enlarge the orifice admitting the liquid to the thread we have hollowed out or turned down partially the part 80 of the flank of the thread disposed opposite the pointed tongue 81 which terminates the said thread on the side where the liquid is admitted. This is clearly apparent in the said figure.

In fig.8 we have designated by the plane 82 the end of the thread of the worm. The normal width of the thread of the worm in the axial direction of the said thread corresponds to the length of the line 83. If we turn down the point 84 in conformity with fig.6 for example along the line 85 indicated by dots then we shall effect an enlargement which will attain the length of the line 86. If we hollow out the flank of the worm thread opposite the point 84 of if we turn downward completely or partiall the said point we willeffect an enlargement attaining the length of the line 88.

In practice we must seek to avoid sharp angles which may cause eddies and vibrations. The actual shaping will follow , for example , dotted lines 89 and 90, lines which coindide therefore.

Resume not translated

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